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TITLE: MEASURING METHOD OF FILM THICKNESS

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ABSTRACT:

PURPOSE: To prevent occurrence of an error in measurement of a film thickness and to enable execution of highly precise measurement by measuring unevenness or a curve of a wafer and by correcting nonuniformity of an incident angle caused by the unevenness or the curve.

CONSTITUTION: When a height of the surface of a wafer 6 is measured, a polarizer 2, a 1/4 wave plate 3 and an analyzer 4 provided on the optical axis of an **ellipsometer** are made to escape from this optical axis, a wafer stage 7 is moved up and down so that the reflection intensity of an incident light from a light source 1 be maximum, and the height of the wafer at that point is

measured. Then, the stage 7 is tilted by a corrective **angle** (d) determined by tan (d)=a/b by using a difference (a) between the heights of two points in the vicinity of the measuring point and a distance (b) between the **planes** of the two points, so that an **angle** of incidence on a sample from the light source 1 be calibrated. In a state wherein this **angle** of incidence is fixed at any measuring point, a film thickness at a prescribed measuring point is measured by the **ellipsometer**.

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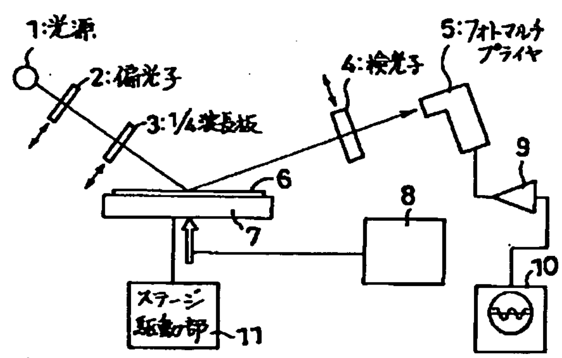
(54)【発明の名称】　膜厚測定方法

(57)【要約】

【目的】　ウェハの凹凸やソリによる測定値の誤差が生じない膜厚の測定方法を提供する。

【構成】　ウェハの凹凸やソリを測定して、その凹凸やソリによって生じる入射角のばらつきを補正することにより、常に光軸に対して一定の入射角度を保った状態でエリプソメトリ法により膜厚の測定を行う。



【特許請求の範囲】

【請求項1】　光軸上に沿って、エリプソ光源の光を直線偏光に変える偏光子と、その光が入射するステージ上に載置されたウェハと、そのウェハを反射した反射光を検光する検光子とが順に配列され、その検光された光の光電流に応じて薄膜の厚さを求める解析手段を有するエリプソメータを用いて上記試料の膜厚を測定する方法において、上記ウェハ面内の複数の測定点について、上記入射光の反射強度が最大となるよう上記ステージを上下移動させ、その移動距離から上記複数の測定点における基準面からの高さを求め、所定の測定点における膜厚を、その所定の測定点近傍の２点の高さの差ａおよびこの２点の平面間の距離ｂを用いて、下記（Ａ）式により求めた補正角度αだけ上記ステージを傾斜させることにより、上記エリプソ光源から試料へ入射する入射角度を較正し、この入射角度を上記測定点のいずれにおいても、一定とした状態で上記エリプソメータにより測定することを特徴とする膜厚測定方法。

$\tan\alpha = a/b$ ‥‥（Ａ）

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、膜厚測定方法に関し、特にエリプソメータを用いた測定方法に関する。

【０００２】

【従来の技術】物体の表面で光が反射する場合に、光の偏光状態は反射の前後で変化する。この点を利用したのが偏光解析法である。すなわち、この偏光状態の変化を測定することにより物体の光学定数や表面の性質を知ることができる。

【０００３】エリプソメータは、この偏光解析法を実現するための装置である。図５は従来例に用いられる装置の構成図である。光源５１の光軸上に、スリット５８、光チョッパ７０、回転偏光子５２、１／４波長板５３、膜厚を測定すべきウェハ６１を載置するウェハステージ５７が設けられ、このウェハ６１を反射した反射光の光軸上にアパーチュア５９、回転検光子５４、フォトマルチプライヤ５５が配され、さらに選択増幅器６０、オシ＊ロスコープ５０が順に接続されている。

【０００４】この構成による従来のエリプソメータでは、まず、光源５１からのスリット５８を通過した光は、光チョッパ７０により変調され、回転偏光子５２さらに１／４波長板５３を通過した光は直線偏光に変わり、ウェハ６１に入射される。このウェハ６１に入射した光の反射光は、回転検光子５４で検光される。この光はフォトマルチプライヤ５５で受けるとき、光電流を生じるが、この光電流をエレクトロニック回路で監視して偏光の回転振動の振幅が極小となるような回転偏光子５２と回転検光子５４の角度を求める。この光電流は選択増幅器６０を通って、画像情報となってオシロスコープ５０にその波形が映し出される。

【０００５】以上の構成および原理により、ウェハ６１に偏光をあてて、その反射光の反射係数比および位相差により、薄膜の厚さを求めることができる。すなわち、波長λ、入射角ϕで入射した光の入射面に平行な電場の振動成分（ｐ成分）と、垂直な電場の振動成分（ｓ成分）のそれぞれの反射率r_p，r_sは、(1) 式および (2) 式に示すようになる。

【０００６】

【数１】

$$r_p = \frac{r_{1p} + r_{2p} e^{-i\delta}}{1 + r_{1p} \cdot r_{2p} e^{-i\delta}} \quad \cdots\cdot (1)$$

$$r_s = \frac{r_{1s} + r_{2s} e^{-i\delta}}{1 + r_{1s} \cdot r_{2s} e^{-i\delta}} \quad \cdots\cdot (2)$$

r_1：空気－薄膜間の反射率
r_2：薄膜－基板間の反射率

ここで、位相差δは、ｎを屈折率とすると、(3) 式で与えられる。また、反射係数比（r_p／r_s）は、(4) 式で与えられる。

【０００７】

【数２】

$$\delta = \frac{360}{\lambda} d \left(n^2 - \sin^2\phi\right)^{1/2} \quad \cdots\cdot (3)$$

【０００８】

【数３】

$$r_p / r_s = \tan\phi\, e^{i\Delta} \quad \cdots\cdot (4)$$

このように、ｐ成分，ｓ成分で振幅比が異なり、かつ相対的に位相差が生ずるため、直線偏光は楕円偏光として反射される。従って、偏光子および検光子の設定角をそれぞれP_0，A_0とすれば、(4) 式で示す相対的な位相差Δおよび入射角ϕはそれぞれ(5) 式，(6)式に示すようになる。

【０００９】

※【数４】

$$\Delta = \frac{\pi}{2} + 2P_0 \quad \cdots\cdot (5)$$

$$\phi = A_0 \quad \cdots\cdot (6)$$

【００１０】

【発明が解決しようとする課題】ところで、従来技術では、半導体の絶縁膜たとえば、特に薄い酸化膜を測定す

る方法として、上述したようなエリプソメトリによる方法が最も精度が高く、広く用いられているものの、実際のＬＳＩウェハは熱処理等の影響により、ウェハ上に凹凸やソリが発生するため、測定時のエラーの原因となっていた。

【００１１】これは、測定値がウェハの入射角φに依存するため、ウェハの凹凸やソリでその入射角度がばらつくためである。本発明は以上の点に鑑みてなされたものであり、ウェハの凹凸やソリによる測定値の誤差が生じない膜厚の測定方法を提供することを目的とする。

【００１２】

【課題を解決するための手段】上記の目的を達成するために、本発明の膜厚の測定方法は、光軸上に沿って、エリプソ光源の光を直線偏光に変える偏光子と、その光が入射するステージ上に載置されたウェハと、そのウェハを反射した反射光を検光する検光子とが順に配列され、その検光された光の光電流に応じて薄膜の厚さを求める解析手段を有するエリプソメータを用いて上記試料の膜厚を測定する方法において、上記ウェハ面内の複数の測定点について、上記入射光の反射強度が最大となるよう上記ステージを上下移動させ、その移動距離から上記複数の測定点における基準面からの高さを求め、所定の測定点における膜厚を、その所定の測定点近傍の２点の高さの差ａおよびこの２点の平面間の距離ｂを用いて、下記（Ａ）式により求めた補正角度αだけ上記ステージを傾斜させることにより、上記エリプソ光源から試料へ入射する入射角度を較正し、この入射角度を上記測定点のいずれにおいても、一定とした状態で上記エリプソメータにより測定することによって特徴付けられる。

【００１３】$\tan\alpha = a / b$････（Ａ）

【００１４】

【作用】エリプソメータにより膜厚を測定する場合、その測定すべきウェハに凹凸やソリのある場合、入射角にばらつきが生じ、その結果測定値には誤差を生じる。

【００１５】そこで、この点を解消したのが本発明で、以下に図４を参照しつつ、その作用を説明する。（ａ）図に示すようにウェハがフラットの場合、入射角θ_1はウェハ上のどの測定点においても、同一となり、またその反射角θ_2も同一となる。この入射角θ_1および反射角θ_2は基準面におけるものとすると、（ｂ）図に示すようにウェハが凸状に歪んでいる場合、たとえば、Ａ点、Ｂ点、Ｃ点における入射角はそれぞれ異なる値をとる。そこでＡ点における入射角は$\theta_1 + \alpha$となり、ウェハがフラットの場合の入射角θ_1と等しくなるように較正するために、本方法では、たとえば、Ａ点における入射角を求める場合、すでに測定されているＢ点、Ｃ点における膜厚h_2，h_1およびＢ点およびＣ点の平面間の距離をｂを用いて（Ｂ）式により、較正すべき入射角度αを求めることができる。

【０００１６】$\tan\alpha = (h_1 - h_2) / b$････（Ｂ）

従って、ウェハの入射面をαだけ傾けることにより、常に光軸に対して一定の入射角度を保つことができ、その結果、膜厚の測定誤差を生じることがない。

【００１７】

【実施例】図１は本発明実施例に用いられるエリプソメータの構成図である。光源１の光軸上に、偏光子２、１／４波長板３、膜厚を測定すべきウェハ６を載置するウェハステージ７、このウェハ６を反射する反射光を検光する検光子４および、フォトマルチプライヤ５が配されている。さらに増幅器９、オシロスコープ１０が順に配列されている。また、ウェハステージ７は縦横、上下移動自在で、ウェハステージ７近傍にはウェハステージ７を所定位置にまで駆動するステージ駆動部１１が備えられている。さらに、入射角度の較正を行うために、ウェハ６の面内の複数の測定点における基準面からの高さと所定の高さとの差を検出し、高さデータとして記憶するデータ部８が設けられている。この高さデータを作成する工程は自動的に行うように構成されている。

【００１８】本発明実施例は以上の構成によるエリプソメータを用いて行う。以下にその方法について説明する。まず、測定すべきウェハ６の表面の高さを測定する。この測定を行う場合、このエリプソメータの光軸上に設けられた偏光子２、１／４波長板３、検光子４をこの光軸上から外し、光源１からの入射光の反射強度が極大となるようウェハステージ７を上下に移動させて、その点におけるウェハ高さを測定する。この高さと所定の高さとの差は、図２に示すような高さデータとしてデータ部８に記憶させる。この高さデータから図３（ａ）図は、ウェハ６の凹凸を示すフラットネス等高線を、所定の高さを実線、所定の高さ以上を破線、所定の高さ以下を一点鎖線で表したものである。また、図３（ｂ）図は、これらのデータからシュミレーションを行ってウェハの表面の状態を立体的に表したものである。

【００１９】次に、図４に示すように、たとえば、Ａ点での入射角の較正をする場合、上述したように、Ａ点における入射角をウェハがフラットの場合の入射角θ_1と等しくなるように較正する。たとえば、Ａ点における入射角を求める場合、すでに測定されているＢ点、Ｃ点における膜厚h_2，h_1およびＢ点およびＣ点の平面間の距離をｂを用いて（Ｂ）式により、較正すべき入射角度αを求める。

【００２０】そして、ステージ駆動部１１の駆動により、ウェハステージ７をαだけ傾斜させることにより、常に光軸に対して一定の入射角度を保つことができ、膜厚の測定値の誤差を解消できる。

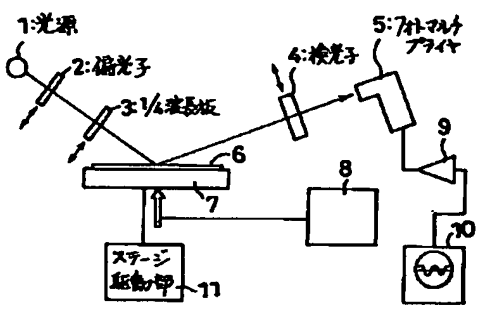
【００２１】なお、入射角を上述したように設定して、順次ウェハ６上の点の膜厚を測定していくが、従来例で述べたように、本実施例においても薄膜の厚さを求める原理は同様であり、反射係数比および位相差にから求める。

【0022】
【発明の効果】以上説明したように、本発明の膜厚測定方法によれば、ウェハの凹凸やソリを測定して、その凹凸やソリによって生じる入射角のばらつきを補正することにより、常に光軸に対して一定の入射角度を保った状態でエリプソメトリ法により測定を行うようにしたので、膜厚測定の誤差が生じることがなく、高精度の測定が可能となる。

【図面の簡単な説明】
【図1】本発明実施例に用いられるエリプソメータの構成図
【図2】本発明実施例に用いられるウェハの高さデータを示す図
【図3】本発明実施例に用いられるウェハの表面を表す図

【図4】本発明実施例を説明する図
【図5】従来例を説明する図
【符号の説明】
1····光源
2····偏光子
3····1／4波長板
4····検光子
5····フォトマルチプライヤ
6····ウェハ
7····ウェハステージ
8····データ部
10····オシロスコープ

【図1】



【図2】

C/R	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
2	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
3	·	·	·	·	-14	-17	-18	-18	·	·	·	·	·	·	·
4	·	·	·	-12	-14	-16	-18	-16	-18	·	·	·	·	·	·
5	·	·	·	-11	-13	-13	-16	-15	-17	-9	·	·	·	·	·
6	·	·	-8	-11	-10	-10	-13	-12	-16	-15	·	·	·	·	·
7	·	·	-5	-9	-8	-8	-11	-10	-13	-16	·	·	·	·	·
8	·	·	-6	-8	-5	-7	-9	-7	-12	-16	·	·	·	·	·
9	·	·	-9	-6	-6	-5	-7	-6	-8	-16	·	·	·	·	·
10	·	·	-8	-8	-7	-3	-4	-7	-8	-16	·	·	·	·	·
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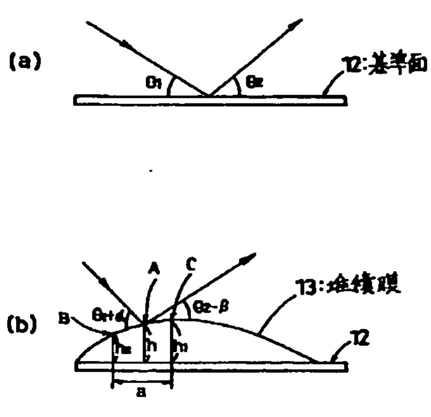
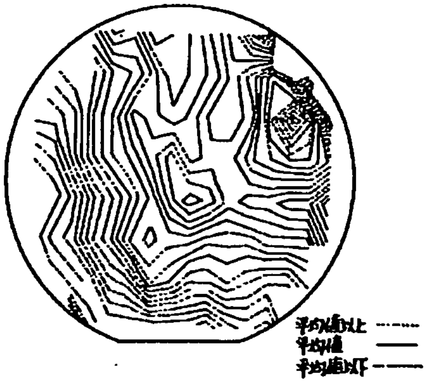
17	·	·	·	-1	-11	-9	-3	-7	-10	·	·	·	·	·	·
18	·	·	·	·	-3	-7	0	-3	·	·	·	·	·	·	·
19	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
20	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·

【図4】

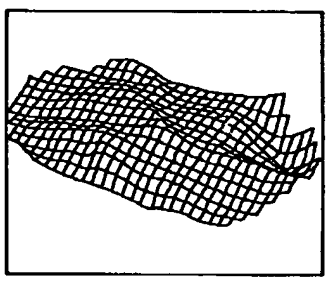


【図3】

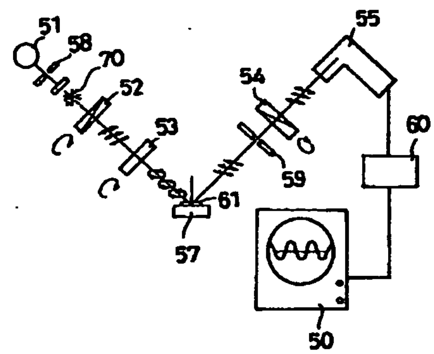
(a)



(b)



【図5】



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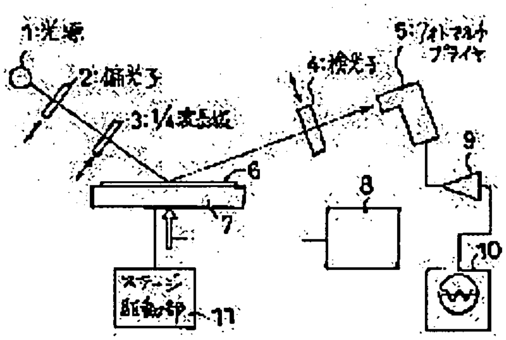
(71)Applicant : **SHARP CORP**

(72)Inventor : **KAWAHIRA HIROTOSHI**

(54) MEASURING METHOD OF FILM THICKNESS

(57)Abstract:

PURPOSE: To prevent occurrence of an error in measurement of a film thickness and to enable execution of highly precise measurement by measuring unevenness or a curve of a wafer and by correcting nonuniformity of an incident angle caused by the unevenness or the curve.



CONSTITUTION: When a height of the surface of a wafer 6 is measured, a polarizer 2, a 1/4 wave plate 3 and an analyzer 4 provided on the optical axis of an ellipsometer are made to escape from this optical axis, a wafer stage 7 is moved up and down so that the reflection intensity of an incident light from a light source 1 be maximum, and the height of the wafer at that point is measured. Then, the stage 7 is tilted by a corrective angle (d) determined by tan (d)=a/b by using a difference (a) between the heights of two points in the vicinity of the measuring point and a distance (b) between the planes of the two points, so that an angle of incidence on a sample from the light source 1 be calibrated. In a state wherein this angle of incidence is fixed at any measuring point, a film thickness at a prescribed measuring point is measured by the ellipsometer.

LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

CLAIMS

[Claim(s)]
[Claim 1] The polarizer which changes the light of the ERIPUSO light source into the linearly polarized light along an optical-axis top, and the wafer laid on the stage as for which the light carries out incidence, In the approach the analyzer which analyzes light the reflected light which reflected the wafer measures the thickness of the above-mentioned sample using the ellipsometer which has an analysis means for it to be arranged in order and to ask for the thickness of a thin film according to the photocurrent of the light which analyzed light About two or more point of measurement within the above-mentioned wafer side, vertical migration of the above-mentioned stage is carried out so that the reflectivity of the above-mentioned incident light may serve as max. It asks for the elevation in two or more above-mentioned point of measurement from the migration length. Only the amendment include angle alpha which asked for the thickness in predetermined point of measurement by the following (A) type using the distance b between the difference a of the height of two near [that / predetermined] the point of measurement, and the flat surface of these two points by making the above-mentioned stage incline The thickness measurement approach characterized by measuring by the above-mentioned ellipsometer in the condition of having proofread to the sample whenever [incident angle / which carries out incidence], and having set whenever [this incident angle] constant from the above-mentioned ERIPUSO light source also in any of the above-mentioned point of measurement to it.
tan alpha=a/b .... (A)

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] Especially this invention relates to the measuring method using an ellipsometer about the thickness measurement approach.
[0002]
[Description of the Prior Art] When light reflects on the surface of a body, the polarization condition of light changes before and after reflection. Polarization analysis used this point. That is, an objective optical constant and a surface property can be known by measuring change of this polarization condition.
[0003] An ellipsometer is equipment for realizing this polarization analysis. Drawing 5 is the block diagram of the equipment used for the conventional example. The wafer stage 57 which lays a slit 58, a light chopper 70, the rotatory polarization child 52, the quarter-wave length plate 53, and the wafer 61 that should measure thickness on the optical axis of the light source 51 is formed, aperture 59, the rotation analyzer 54, and a photomultiplier 55 are allotted on the optical axis of the reflected light which reflected this wafer 61, and the selection amplifier 60 and an oscilloscope 50 are connected further in order.
[0004] In the conventional ellipsometer by this configuration, the light which passed the slit 58 of the light source 51 is first modulated by the light chopper 70, the light which passed the quarter-wave length plate 53 to the rotatory polarization child 52 pan changes to the linearly polarized light, and incidence is carried out to a wafer 61. The reflected light of the light which carried out incidence to this wafer 61 analyzes light with the rotation analyzer 54. Although this light produces a photocurrent when winning popularity by the photomultiplier 55, it asks for the include angle of the rotatory polarization child 52 and the rotation analyzer 54 with which this photocurrent is supervised in an electro nick circuit, and the amplitude of the rotational vibration of polarization serves as the minimum. This photocurrent passes along the selection amplifier 60, serves as image information, and that wave projects it on an oscilloscope 50.
[0005] By the above configuration and principle, polarization can be hit to a wafer 61, and it can ask for the thickness of a thin film according to the reflection coefficient ratio and phase contrast of the reflected light. Namely, each reflection factor rp of the oscillating component (p component) of electric field parallel to the plane of incidence of the light which carried out incidence by wavelength lambda and the incident angle psi, and the perpendicular oscillating component (s component) of electric field and rs (1) A formula and (2) It comes to be shown in a formula.
[0006]
[Equation 1]

$$r_p = \frac{r_{1p} + r_{2p} e^{-i\delta}}{1 + r_{1p} \cdot r_{2p} e^{-i\delta}} \cdots\cdots(1)$$

$$r_s = \frac{r_{1s} + r_{2s} e^{-i\delta}}{1 + r_{1s} \cdot r_{2s} e^{-i\delta}} \cdots\cdots(2)$$

r_1：空気－薄膜間の反射率
r_2：薄膜－基板間の反射率

Here, phase contrast delta is (3) when n is made into a refractive index. It is given by the formula. Moreover, a reflection coefficient ratio (rp/rs) is (4). It is given by the formula.
[0007]
[Equation 2]

$$\delta = \frac{360}{\lambda} d (n^2 - \sin^2\phi)^{1/2} \cdots\cdots(3)$$

[0008]
[Equation 3]

$$r_p / r_s = \tan\phi \, e^{i\Delta} \cdots\cdots(4)$$

Thus, gains differ of p component and s component, and since phase contrast arises relatively, the linearly polarized light is reflected as elliptically polarized light. Therefore, it is the setting angle of a polarizer and an analyzer, respectively P0 and A0 Then, (4) The relative phase contrast delta shown by the formula and the incident angle psi are (5), respectively. It comes to be shown in a formula and (6) types.
[0009]
[Equation 4]

$$\Delta = \frac{\pi}{2} + 2P_0 \cdots\cdots(5)$$

$$\phi = A_0 \cdots\cdots(6)$$

[0010]
[Problem(s) to be Solved by the Invention] By the way, with the conventional technique, as an approach of measuring the insulator layer of a semi-conductor, for example, an especially thin oxide film, although the approach by ellipsometry which was mentioned above had the highest precision and was used widely, since irregularity and a camber occurred on a wafer, the actual LSI wafer caused an error at the time of measurement under the effect of heat treatment etc.
[0011] This is because whenever [incident angle] differs in the irregularity and the camber of a wafer, in order that measured value may be dependent on the incident angle psi of a wafer. This invention is made in view of the above point, and it aims at offering the measuring method of thickness which the error of the measured value by the irregularity or the camber of a wafer does not produce.
[0012]
[Means for Solving the Problem] In order to attain the above-mentioned purpose, the measuring method of the thickness of this invention The polarizer which changes the light of the ERIPUSO light source into the linearly polarized light along an optical-axis top, and the wafer laid on the stage as for which the light carries out incidence, In the approach the analyzer which analyzes light the reflected light which reflected the wafer measures the thickness of the above-mentioned sample using the ellipsometer which has an analysis means for it to be arranged in order and to ask for the thickness of a thin film according

to the photocurrent of the light which analyzed light About two or more point of measurement within the above-mentioned wafer side, vertical migration of the above-mentioned stage is carried out so that the reflectivity of the above-mentioned incident light may serve as max. It asks for the elevation in two or more above-mentioned point of measurement from the migration length. Only the amendment include angle alpha which asked for the thickness in predetermined point of measurement by the following (A) type using the distance b between the difference a of the height of two near [that / predetermined] the point of measurement, and the flat surface of these two points by making the above-mentioned stage incline From the above-mentioned ERIPUSO light source, whenever [incident angle / which carries out incidence to a sample] is proofread, and it characterizes by measuring by the above-mentioned ellipsometer in the condition of having set whenever [this incident angle] constant also in any of the above-mentioned point of measurement.
[0013] tan alpha=a/b .... (A)
[0014]
[Function] When measuring thickness by the ellipsometer and irregularity and a camber are in the wafer which should be measured, dispersion arises in an incident angle and, as a result, an error is produced in measured value.
[0015] Then, this invention canceled this point, and that operation is explained, referring to drawing 4 below. (a) As shown in drawing, when a wafer is a flat, it is the incident angle theta 1. In every point of measurement on a wafer, it becomes the same, and is the angle of reflection theta 2. It becomes the same. This incident angle theta 1 And angle of reflection theta 2 As datum level is shown in the (b) Fig., when the wafer is distorted to convex, the incident angle in an A point, a B point, and C point takes a different value, respectively. Then, the incident angle in an A point is the incident angle theta 1 in case it is set to theta1+alpha and a wafer is a flat. In order to proofread so that it may become equal, by this approach For example, the thickness h2 in the B point and C point which have already been measured when searching for the incident angle in an A point and h1 And it can ask for alpha whenever [incident angle / which should proofread the distance between the flat surfaces of a B point and C point by the (B) type using b].
[0016] tanalpha=(h1-h2)/b .... (B)
Therefore, when only alpha leans the plane of incidence of a wafer, whenever [fixed incident angle] can always be maintained to an optical axis, consequently the measurement error of thickness is not produced.
[0017]
[Example] Drawing 1 is a block diagram of an ellipsometer used for this invention example. The wafer stage 7 which lays a polarizer 2, the quarter-wave length plate 3, and the wafer 6 that should measure thickness on the optical axis of the light source 1, the analyzer 4 which analyzes light the reflected light which reflects this wafer 6, and the photomultiplier 5 are allotted. Furthermore, amplifier 9 and an oscilloscope 10 are arranged in order. Moreover, every direction and vertical migration are free for the wafer stage 7, and about seven wafer stage is equipped with the stage mechanical component 11 which drives the wafer stage 7 even in a predetermined location. Furthermore, in order to perform proofreading of whenever [incident angle], the difference of the height from the datum plane in two or more point of measurement within the field of a wafer 6 and predetermined height is detected, and the data division 8 memorized as height data are formed. The process which creates this height data is constituted so that it may carry out automatically.
[0018] this invention example is performed using the ellipsometer by the above configuration. The approach is explained below. First, the height of the front face of the wafer 6 which should be measured is measured. When performing this measurement, the polarizer 2 prepared on the optical axis of this ellipsometer, the quarter-wave length plate 3, and an analyzer 4 are missed from this optical axis, the wafer stage 7 is moved up and down so that the reflectivity of the incident light from the light source 1 may serve as the maximum, and the wafer height in that point is measured. Data division 8 are made to memorize the difference of this height and predetermined height as height data as shown in drawing 2 . From this height data, a continuous line and more than predetermined height are expressed with a

broken line, and the drawing 3 (a) Fig. expresses [the flatness contour line in which the irregularity of a wafer 6 is shown] below predetermined height with an alternate long and short dash line for predetermined height. Moreover, the drawing 3 (b) Fig. performs a simulation from these data, and expresses the condition of the front face of a wafer in three dimensions.
[0019] Next, incident angle theta 1 in case a wafer is a flat about the incident angle in an A point as mentioned above when proofreading the incident angle in an A point as shown in drawing 4 for example, It proofreads so that it may become equal. For example, the thickness h2 in the B point and C point which have already been measured when searching for the incident angle in an A point and h1 And it asks for alpha whenever [incident angle / which should proofread the distance between the flat surfaces of a B point and C point by the (B) type using b].
[0020] And by the drive of the stage mechanical component 11, when only alpha makes the wafer stage 7 incline, whenever [fixed incident angle] can always be maintained to an optical axis, and the error of the measured value of thickness can be canceled.
[0021] in addition, the principle which asks for the thickness of a thin film also in this example as the conventional example described although it sets up as the incident angle was mentioned above, and the thickness of the point on a wafer 6 is measured one by one -- the same -- a reflection coefficient ratio and phase contrast -- since -- it asks.
[0022]
[Effect of the Invention] Since it was made to measure by the ellipsometry method according to the thickness measurement approach of this invention where whenever [fixed incident angle] is always maintained to an optical axis by measuring the irregularity and the camber of a wafer and amending dispersion in the incident angle produced by the irregularity and camber as explained above, the error of thickness measurement does not arise and highly precise measurement is attained.

[Translation done.]

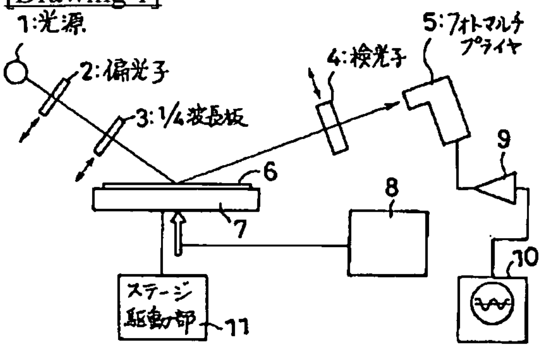
DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The block diagram of an ellipsometer used for this invention example
[Drawing 2] Drawing showing the height data of the wafer used for this invention example
[Drawing 3] Drawing showing the front face of the wafer used for this invention example
[Drawing 4] Drawing explaining this invention example
[Drawing 5] Drawing explaining the conventional example
[Description of Notations]
1 .... Light source
2 .... Polarizer
3 .... Quarter-wave length plate
4 .... Analyzer
5 .... Photomultiplier
6 .... Wafer
7 .... Wafer stage
8 .... Data division
10 .... Oscilloscope

[Translation done.]

DRAWINGS

[Drawing 1]

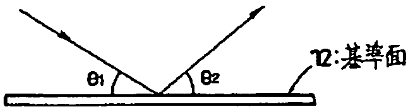


[Drawing 2]

C/R	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
2	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
3	·	·	·	·	-14	-17	-19	-18	·	·	·	·	·	·	·
4	·	·	·	-12	-14	-16	-18	-16	-18	·	·	·	·	·	·
5	·	·	·	-11	-13	-13	-16	-15	-17	-9	·	·	·	·	·
6	·	·	-8	-11	-10	-10	-13	-12	-16	-15	·	·	·	·	·
7	·	·	-5	-9	-8	-8	-11	-10	-13	-16	·	·	·	·	·
8	·	·	-8	-8	-5	-7	-9	-7	-12	-16	·	·	·	·	·
9	·	·	-9	-6	-6	-5	-7	-6	-8	-16	·	·	·	·	·
10	·	·	-8	-8	-7	-3	-4	-7	-9	-16	·	·	·	·	·
11	·	·	-7	-7	-6	-6	-2	-7	-11	-16	·	·	·	·	·
12	·	·	-5	-6	-4	-5	-3	-8	-11	-17	·	·	·	·	·
13	·	·	-3	-4	-4	-5	-5	-8	-10	-15	·	·	·	·	·
14	·	·	0	-6	-5	-7	-4	-8	-11	-14	·	·	·	·	·
15	·	·	4	-9	-10	-8	-4	-7	-12	-15	·	·	·	·	·
16	·	·	·	-6	-14	-9	-3	-7	-12	-12	·	·	·	·	·
17	·	·	·	-1	-11	-9	-3	-7	-10	·	·	·	·	·	·
18	·	·	·	·	-3	-7	0	-3	·	·	·	·	·	·	·
19	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
20	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·

[Drawing 4]

(a)



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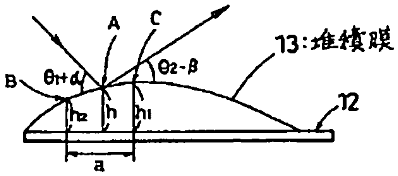
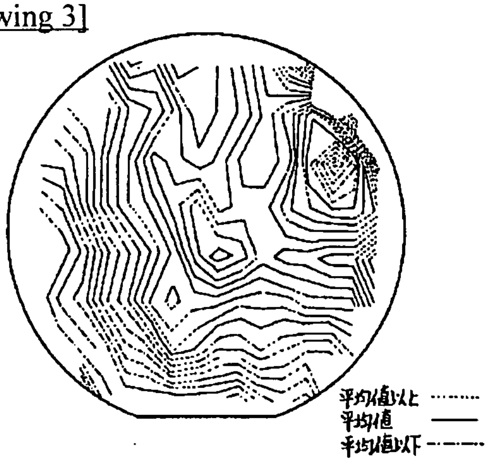


[Drawing 3]

(a)



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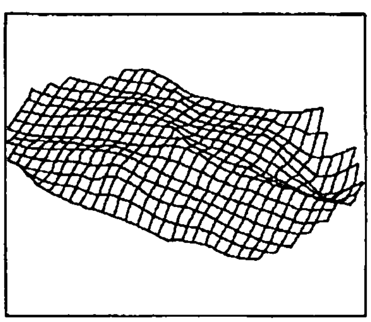
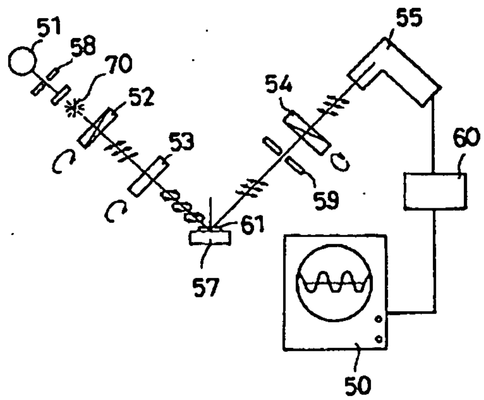


[Drawing 5]



[Translation done.]